The Poaceae Family

Research at the Missouri Botanical Garden

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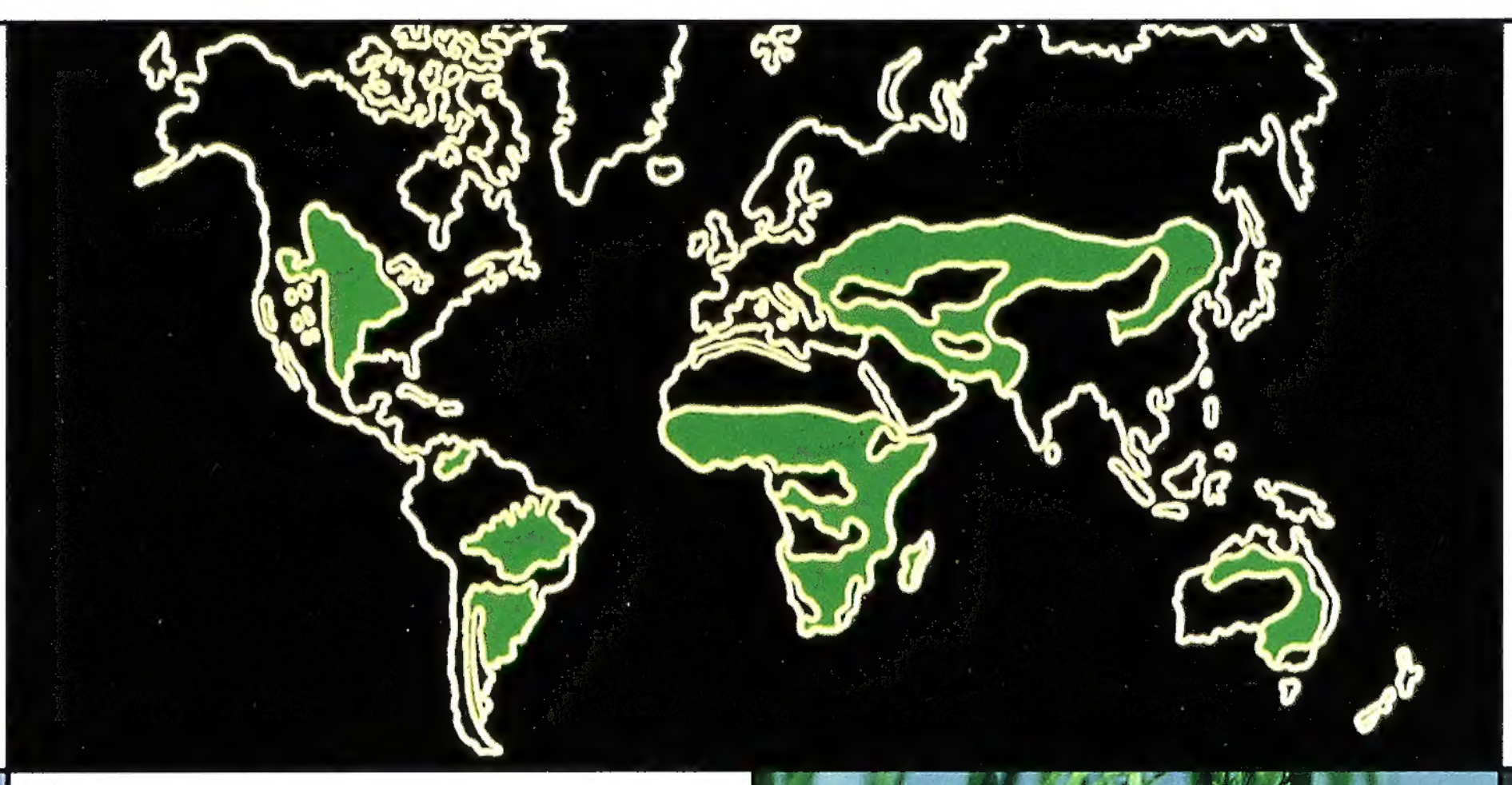
The Poaceae (Gramineae), or grass family, is the fifth largest family of flowering plants in the world, with approximately 10,000 species in 655 genera. It is the most wide-ranging plant family on Earth and one of the most important ecologically and economically. **Grasses provide more species essential for humans than any other plant family and include the world's three dominant grain food crops: corn, rice, and wheat.** Cultivation of grains **made human civilization possible** by providing a reliable supply of excess food, which in turn allowed specialization of human occupations. At left, a wheat farm in the midwestern U.S., one of the "breadbaskets" of the world. [WB] Right: **Grasslands occupy large portions of all continents except Antarctica and are found predominantly in interior regions** with distinct wet and dry seasons in the tropics, or warm and cold seasons in temperate areas. [CBSC] **Dr. Gerrit Davidse, the John S. Lehmann Curator of Grasses at MBG, is one of the world's foremost experts on the Poaceae.**



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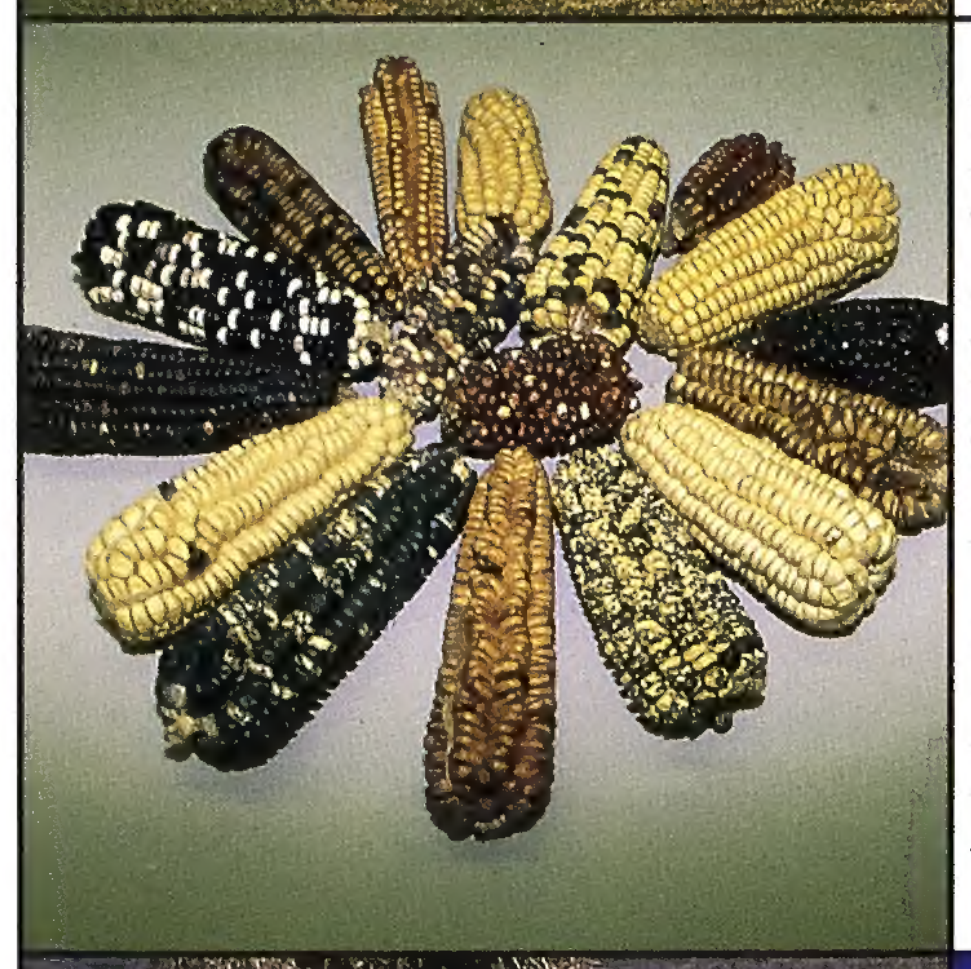
Economic Plants — Food: Grasses supply the major part of the typical American meal shown at right, either directly, as canned corn, wheat flour, and sugar, or indirectly, as food for the animals that supply milk, butter, meat, fats, and gelatin. The only parts of the meal not supplied by grasses are lettuce (Asteraceae, or sunflower, family) and potatoes (Solanaceae, or tomato, family.) **Botanical exploration and research help to strengthen the global food supply by identifying potential sources of new genetic strains.** [RWP]



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Economic Plants — Corn, Zea mays: Corn is the result of selective breeding in Mexico approximately 8,000 years ago, an extraordinary plant breeding achievement. Modern corn is totally dependent on human propagation, as its seeds remain permanently attached to the huge cobs. Centuries of selective breeding have resulted in great genetic variation, as shown by the corn at left. **Genetic diversity is essential for developing more productive and disease-resistant varieties.** [MBG]

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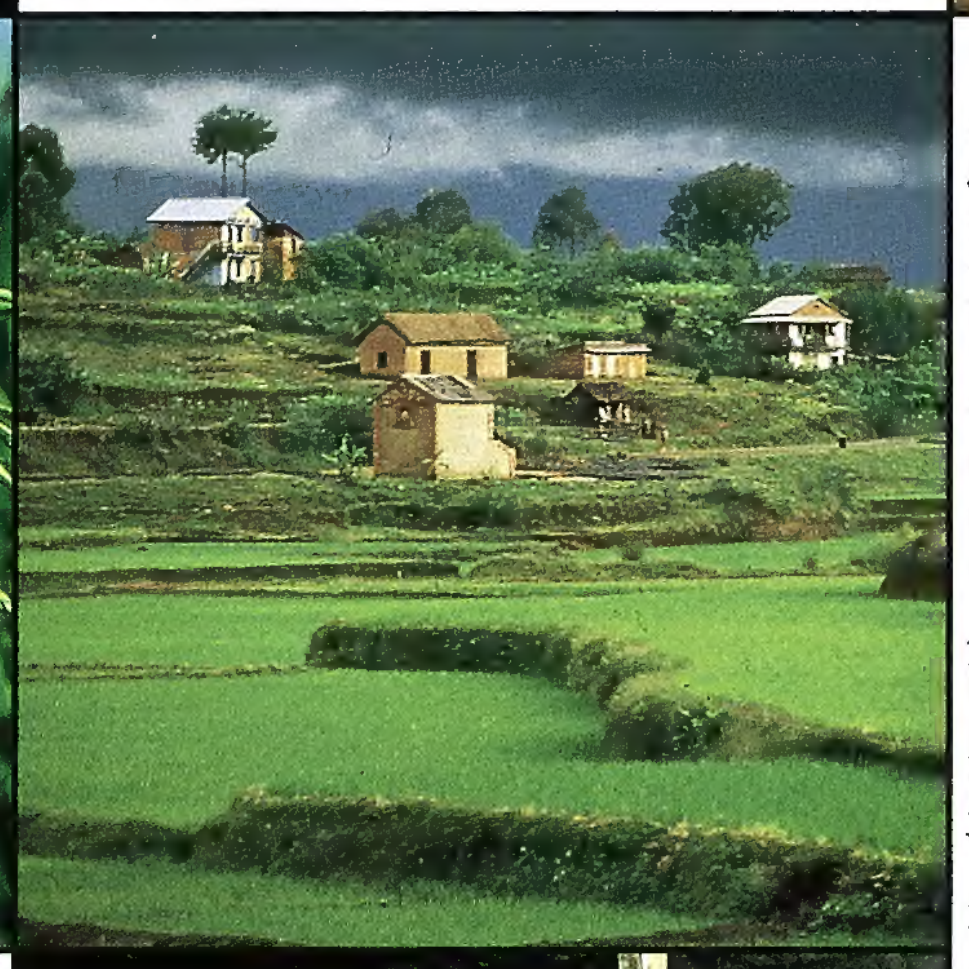
Economic Plants — Wheat: More land is devoted to wheat production worldwide than any other crop, and it is the leading food grain consumed by humans. The two most widely grown species of wheat, *T. turgidum* (durum or macaroni wheat) and *T. aestivum* (common or bread wheat), left, originated in western Asia through natural hybridization among three wild species, followed by a doubling of the chromosome numbers in the hybrids to restore fertility. [SL]



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Economic Plants — Rice: *Oryza sativa* (far left), is the single most important crop of the tropics. A larger proportion of the world's rice crop is eaten directly by humans than any other grain. Native to tropical Asia, rice is a semi-aquatic species with greatest yields obtained under irrigation, as in the paddy fields of Madagascar, left. A second species, *Oryza glaberrima*, has been independently domesticated in Africa. [GD], [LM]

MBG and the Tropics — Worldwide, biodiversity is greatest in the tropics. Two-thirds of all flowering plants — about 170,000 species — occur only there; most are still unknown scientifically and are in danger of extinction. **MBG maintains the world's most active research program in tropical botany, working with local institutions** to provide technical assistance and training and to establish relationships within the worldwide scientific community. **Botanical research helps to provide the scientific basis for conservation priorities and action.**

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Economic plants — Sorghum: Sorghum, (left), and some 30 other species of grasses have been domesticated as cereal crops. Still widely cultivated are oats, *Avena sativa*; rye, *Scale cereale*; barley, *Hordeum vulgare*; and sorghum, *Sorghum bicolor*. Sorghum was domesticated in Africa, where it is still an important crop for human consumption, as in Ethiopia, far left. In other parts of the world, sorghum is used primarily for animal feed. [WB]

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Economic Plants — Sugar cane: *Saccharum officinarum* (left), economically the world's most important non-cereal grass, was probably first domesticated in New Guinea. Familiar refined, white table sugar is a relatively recent development; historically, juice was extracted from the canes by machines such as this primitive sugar press in Ecuador, right, and boiled down to yield a dark brown sugar. [WB], [PMJ]

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Environmental Pressures — Agriculture: Human population growth, especially in the tropics, is the leading cause of deforestation and environmental degradation worldwide. Clearing land for agricultural uses quickly depletes some tropical soils, which cannot regenerate. **Primitive agricultural techniques allow only a few seasons of fertility before soils are exhausted and new land must be cleared,** repeating the process. Many plant and animal species exist only in very small areas; **once these regions are degraded, their genetic treasures are lost before they can be studied and utilized.** The world's population is expected to double in the next few decades; the survival of thousands of species and the **future functioning of global ecosystems depend on international cooperation for sustainable economic development.** Right, a converted forest in northeastern Australia, where Kikuyu grass, *Pennisetum clandestinum*, native to upland East Africa, was introduced as forage grass and has crowded out native species. [BKS]

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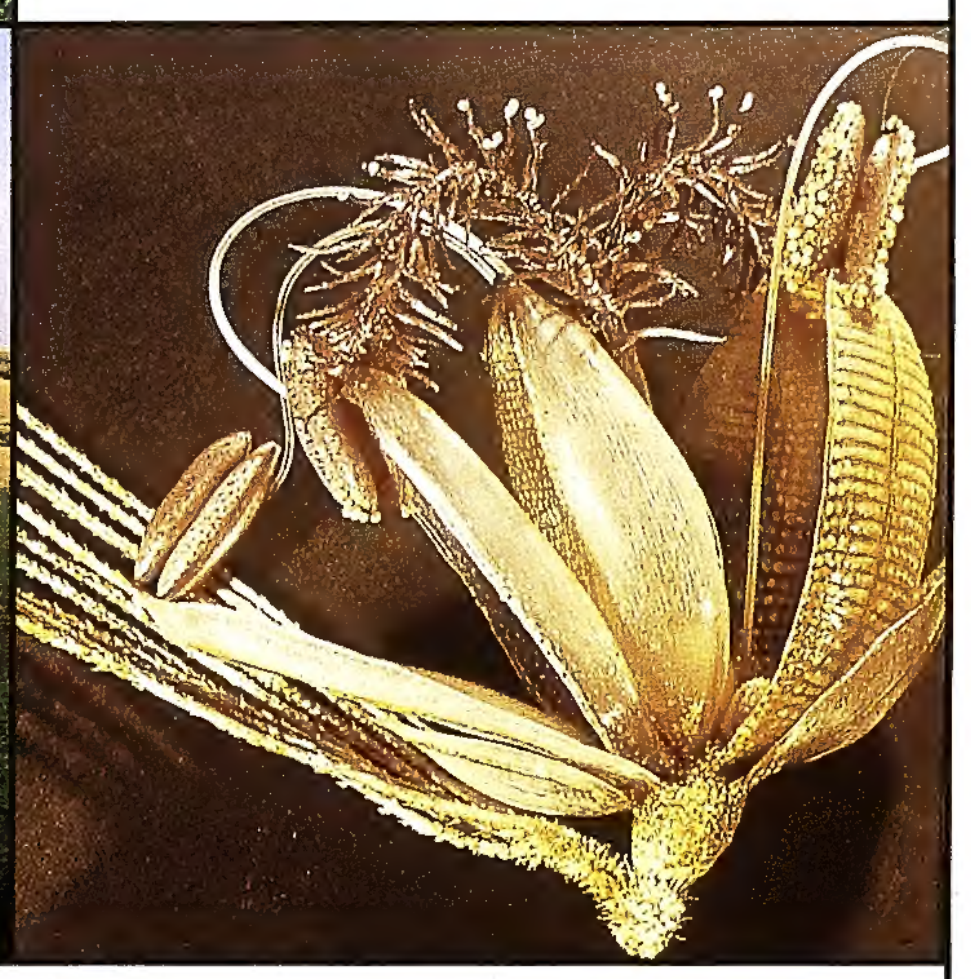
Ecological Balance — Fire: Fire is an essential, natural element in maintaining grasslands and has been used by humans to modify their environment since prehistoric times (left). **Burning reduces invasive woody species and favors herbaceous plants such as grasses that survive by perennial underground buds.** It also clears dead grass and promotes fresh new growth favored by grazing animals. At right, contrasting burned and unburned areas on the Konza Prairie Research Natural Areas (KPRNA) in Kansas. [WD], [TMB]



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Habitat — Prairies: Of all biomes, grasslands support the largest numbers and most diverse array of large mammals, as with these bison at KPRNA. Before conversion to agriculture, North American prairies were one of the largest continuous natural grasslands on Earth. Worldwide, most grasslands have been converted to crops, primarily cultivated grasses. MBG serves as headquarters for the *Flora of North America*, which catalogs and describes for the first time all naturally occurring plants north of Mexico. [DCH]

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Habitat — Savannas: Tropical savannas dominate the interiors of Colombia, Venezuela, Bolivia, and the central plateau of Brazil. **Open grassland, or grassland with widely spaced small trees, is found on well-drained plains and in some seasonally inundated basins.** Continuous gallery forests occur only along rivers, as shown in the background at left in Apure, Venezuela. In the temperate parts of South America, vast native grasslands extend from southern Brazil to the dry, cold plains of Patagonia. [GD]

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Structure — Flowers: Grass flowers are reduced to the basics, typically three stamens, one pistil with two styles, and two lodicules, small structures that swell to allow the anthers and styles to be exserted and exposed to the air. **The flower is usually enclosed by two bracts called the lemma and palea, forming a unit called the floret.** Florets are borne singly or in groups and are held between two additional bracts, or glumes, with the entire structure forming a **spikelet, the basic unit of the grass inflorescence.** The spikelet above of foxtail, *Setaria* sp., consists of two small basal glumes and two florets. Here the upper floret has opened and exserted its stamens and stigmas. Seven bristles subtend the entire spikelet. **The number, form, and arrangements of florets, bracts, spikelets, and inflorescences are extremely varied in the Poaceae and are important in the classification and identification of grasses.** Many of these structures are specialized for more effective seed dispersal and establishment. [RJS]

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Habitat — High altitudes: Worldwide, high-altitude grasslands are dominated by pooid grasses and secondarily by arundinoid and bambusoid grasses. In tropical savannas, by contrast, panicoid and chloridoid grasses predominate. **In South America, grassland dominates the high plateaus,** or *puna*, of Peru and Bolivia, as seen at right in La Paz Province. Familiar northern turfgrass genera such as *Poa* (bluegrasses), *Festuca* (fescues), and *Agrostis* (bentgrasses) are common in this region also. [JCS]

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Habitat — Steppes: When water is unavailable for irrigation or soil is too rocky for row crops, grassland is primarily used for grazing domestic animals, as above in Xinjang, China. In areas where rainfall is sufficient or irrigation is available, grasslands have been largely converted to cultivated crops, especially cereals. **MBG is the editorial center and overall coordinator for the Flora of China project, an international collaboration** to produce the first concise, English-language account of all the plants of China. **Habitat — Dry: Grasses dominate many of the world's drier climates.** In regions where competition for water is severe, grasses often grow as well-isolated bunches, as shown at left in a spinifex grassland dominated by *Triodia* species in western Australia. As with other groups of organisms, **most native Australian grasses are endemic, that is, they occur nowhere else on Earth.** [PCH], [BKS]

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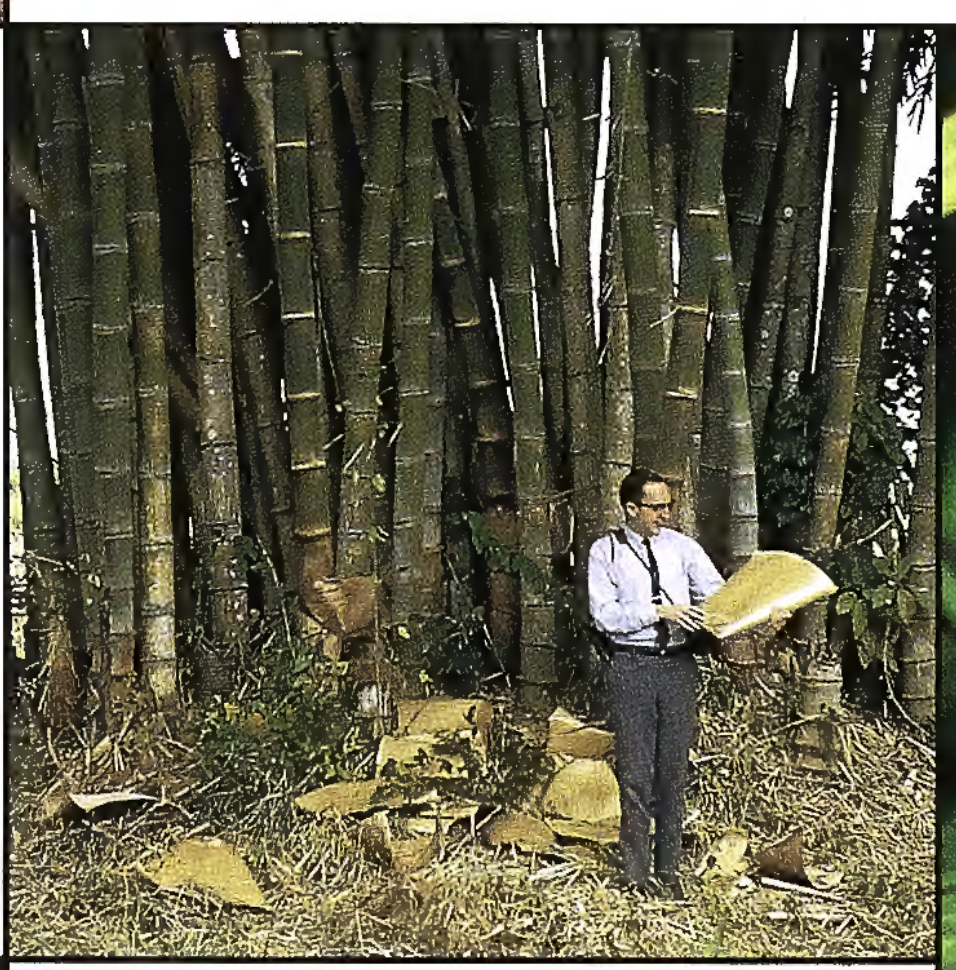
Habitat — Africa: In addition to the well-known savannas and velds of the African plains with their huge herds of grazing animals and their predators, grasses also dominate many high mountains and plateaus, as on the Kitulo Plateau in southern Tanzania at left. **MBG is the U.S. center for African botany, and its research program there has expanded dramatically in recent years.** [REG] **Life Cycle — Varied:** Although grasses are predominantly herbaceous, they vary from tiny annuals such as *Tovarochloa peruviana*, which may be only one cm tall at maturity and **can complete its entire life cycle in six weeks,** to huge woody bamboos such as *Dendrocalamus giganteus*, shown at right in cultivation in Honduras, which flowers only once in its lifetime, produces seed, and then dies. In the extreme case of *Phyllostachys bambusoides*, native to Asia, **a life cycle of 120 years has been demonstrated.** The man in the photo holds a culm leaf, a specialized leaf of woody bamboos that supports young, weak stems but is quickly shed after the stems harden. [WB] ▶



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Pollination — Wind: Grasses are typically wind pollinated, producing dangling anthers and feathery stigmas for catching pollen, as in the species of *Chondrosum* from Arizona, above. The white stigmas are held upright and the yellow stamens dangle from the spikelets. [DK] **Classification — Disputed:** Although no universal agreement exists about the classification of grasses, the widely used system of W. D. Clayton and S. A. Renvoize in *Genera Graminum* recognized 40 tribes in six subfamilies, Bambusoideae, Pooideae, Centothecoideae, Arundinoideae, Chloridoideae, and Panicoideae. *Anomochloa* (Bambusoideae), a genus with a single species, **A. marantoidea (left), probably represents the most primitive living grass,** as demonstrated by recent studies. It occurs only in Bahia in eastern Brazil, where it is known from several small populations in the rapidly disappearing coastal rain forest. Interpreting its large, bizarre spikelets has been controversial since its discovery a century ago. [RJS]

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Seed dispersal — Birds: *Lasiacis ruscifolia*, right, is a widespread forest-edge panicoid grass of tropical America that produces large, berry-like spikelets. The black color appears only after the flower has been successfully pollinated and the seed has matured. The inner epidermis of the black spikelet bracts produces abundant oil; the spikelets are **eaten by birds and remain intact after digestion, an effective dispersal mechanism that increases the possibility of wider geographic distribution.** [GD]

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Subfamily — Pooideae (133 genera, 3,273 species): Anatomical and chromosomal characters are very important in classification of grasses. **Pooid grasses are predominantly found in Mediterranean and temperate climates and in high tropical mountains. All have normal or C_3 photosynthesis.** *Elymus villosus* (left), found in open forest areas in eastern U.S., is a distant wild relative of wheat, barley, and rye, all members of the tribe Triticeae. Many species of this tribe are important range grasses in temperate areas. [WB]

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Subfamily — Bambusoideae (91 genera, 1,111 species): Bamboos may be woody or herbaceous and are a group of grasses found primarily in the shade of lowland rain forests. Unusual are the five known species of *Eremites*, which produce **large underground spikelets at the tips of rhizomes, a rare seed dispersal and planting mechanism** shared with only three other unrelated New World genera. At left, an undescribed species of *Eremites* from eastern Brazil. [TRS]

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Subfamily — Arundinoideae (45 genera, 614 species): Arundinoid grasses include pampas grasses such as *Cortaderia nitida*, left, from Táchira, Venezuela, and **the common reed, Phragmites australis, one of the world's most widely distributed species.** Arundinoids are primarily **restricted to the southern hemisphere, in what is called a Gondwanaland distribution.** This largely C_3 subfamily is under intense scrutiny; **as presently defined, it is probably not a single lineage from a common ancestor.** [LGC]

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Subfamily—Cloridoideae (145 genera, 1,358 species): This is a predominantly tropical group, and many have radiated into drier, more open habitats. **With one exception they have a specialized form of photosynthesis called C_4. More dioecious species, with separate male and female plants, occur among the cloridoids than any other subfamily.** Spikelets and inflorescences of females tend to be more differentiated for seed dispersal; at maturity, the entire female inflorescence of *Cyclostachya stolonifera* (left) curls into a circular tumbleweed that blows over the plains of its native habitat in San Luis Potosi, Mexico. **Subfamily—Panicoideae (208 genera, 3,290 species): Panicoid grasses consist of several small tribes and two of the great, largely tropical tribes, Paniceae (C_3 and C_4 photosynthesis) and Andropogoneae (C_4).** In *Cenchrus incertus* (Paniceae), right, the common sand bur of the eastern U.S., groups of spikelets are surrounded by burs made from highly modified inflorescence branches. Burs are dispersed when they stick to passing animals. [JRR], [WB]

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Tribe — Andropogoneae (ca. 85 genera, 960 species): Many andropogonoids are important dominants in tropical grasslands as well as in tallgrass prairies of North America. Little bluestem, *Schizachyrium scoparium* (right), is an important species of eastern North America and can be seen in MBG prairie restoration projects in the St. Louis area. Its pedicels and attached inflorescence parts bear numerous long hairs that enable the small mature fruits to be dispersed by the wind. [WB]

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New Discoveries — Grasses: Dozens of new species and even a few new genera of grasses are described each year, especially from the tropics. Many, such as *Chusquea amistadensis*, right, from high in the mountains between Panama and Costa Rica, are **totally new discoveries of local endemics never previously studied or collected by botanists. Others are recognized through intensive studies of previously known species. MBG scientists describe about 200 new species each year.** [GD]

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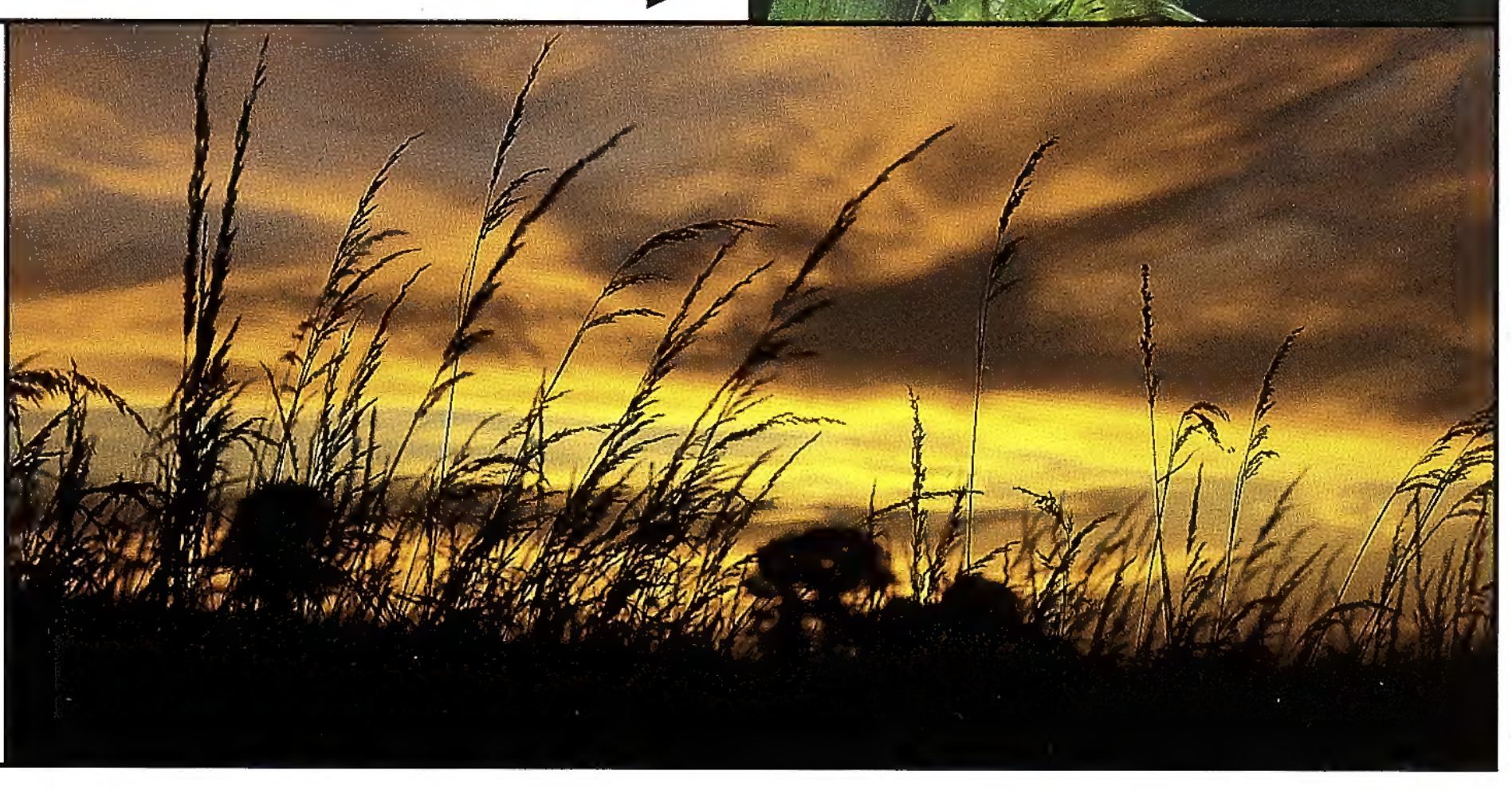
Habitat Restoration — Grasslands: Creating and restoring pre-settlement habitats is a priority at MBG's Shaw Arboretum, where the tallgrass prairie at right has been in development since 1980. Plants, the basis of life on Earth, supply food, regulate climate, and provide materials for shelter, industrial products, and medicines. **The future of humankind depends on developing the basic scientific information to understand and preserve Earth's biodiversity.** [WD]



Dedicated to Edgar Anderson, 1897-1969, botanist. Dr. Anderson was a student of the origin and evolution of corn and other grasses, a teacher, and a director of the Missouri Botanical Garden, 1954-58.

Research at the Missouri Botanical Garden

Over fifty Ph.D.-level scientists, many of whom live abroad, technical staff, and graduate students devote their work to studying plants and to exploration of selected regions. These efforts are concentrated in Mesoamerica, South America, subsaharan Africa, Madagascar, China, and North America. Individual MBG scientists are specialists in the plants of particular regions or in the classification of major plant families. MBG serves as headquarters of the Center for Plant Conservation and for the major collaborative projects *Flora of China, Flora Mesoamericana,* and *Flora of North America*, and MBG floristic research and library resources are available on the Internet. MBG collaborates with local institutions in each country where it conducts research, providing technical assistance, helping to find funding, establishing relationships with the worldwide scientific community, training botanists in the field and at MBG, and helping build infrastructure. Botanical research helps provide the basic scientific knowledge for conservation policies to preserve global biodiversity.

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MBG = Missouri Botanical Garden
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[CBSC] Courtesy of Carolina Biological Supply Company
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